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50. Internationales Wissenschaftliches Kolloquium
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Shen-Yung Lin

The Analysis of Cutting Performance for Different Materials Coating Tools in High-Speed Machining of Mold Steels

ABSTRACT

Different materials coated on milling tools (carbide) such as TiCN, TiAlN, TiN and DLC are integrated in this study for the analysis of cutting performance such as tool wear, surface roughness and noise induced in high-speed machining of mold steels such as NAK80 and SKD61 under different combinations of cutting conditions. It tries to find out the advantages and adaptabilities in various coating tools being suitable for which cutting circumferences with specific performance request.

High-speed milling experiments of NAK80 and SKD61 mold steels with four materials coating tools were carried out in the laboratory. The tool wear was measured through the toolmaker's microscope and the roughness of the machined surface was measured by the roughness measuring instruments after each surface layer removed from the workpiece in the experiment. Besides, the noise-mediator was used to detect cutting noise during each surface layer workpiece removing of high-speed milling process, and the curl chips removed from the workpiece were also collected for the result verifications in advance.

Good surface quality and less amount of tool wear can be acquired under the cutting conditions of high-speed revolutions, small feed rate and small depth of cut for four materials coating tools. From the observations of the annealing temperature from the removed chips and the analysis of the cutting noise levels, TiAlN material coating tool has the better tool life and it is suitable for rougher high-speed machining. While DLC material coating tool only has a good surface roughness in shallow cut and hence it is not suitable for high-speed machining of mold steel with excellent cutting performance request.

CONCLUSION

The experiment integrates four different coating tools, TiCN, TiAlN, TiN and DLC, under the high-speed cutting conditions, and compares their cutting performances (tool flank wear, machined surface roughness and cutting noise induced) on the machining of common use mold steel (NAK80, SKD61). It tries to find which situation and occasion that the four kinds of different coating materials may be appropriate utilized with specific function required. From the above analyses, the following conclusions can be drawn:

1. The abrasive wear of the coating tools is affected by different cutting condition and various materials coated on tool. As the cutting temperature is raised, the Aluminum element is interacted with the oxygen in the air and a thin film of Al2O3 is formed against the abrasive wear during high temperature region and enhance cutting tool wear durability. Among the four coating materials investigated in this study, TiAlN is therefore the most suitable for high-speed cutting of mold steel.

2. On the machined surface roughness aspect, it is found that better surface quality may be acquired in order as DLC, TiCN, TiN and TiAlN. This phenomenon was occurred only at the

beginning cutting with sharp tool tip.

3. Generally speaking TiAlN coating is more adaptable to rough milling mold steel because of its high durability in abrasive wear. While DLC coating is more suitable utilized for finish milling because small surface roughness can be obtained when a shallow machining of mold steel was taken.

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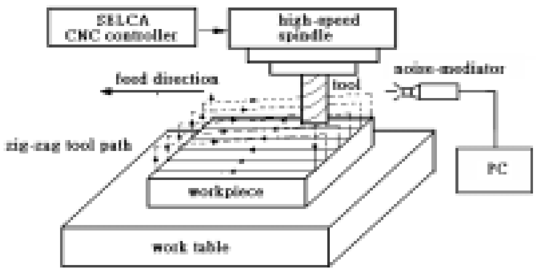

Figure 1 Experimental set-up and cutting path arrangement

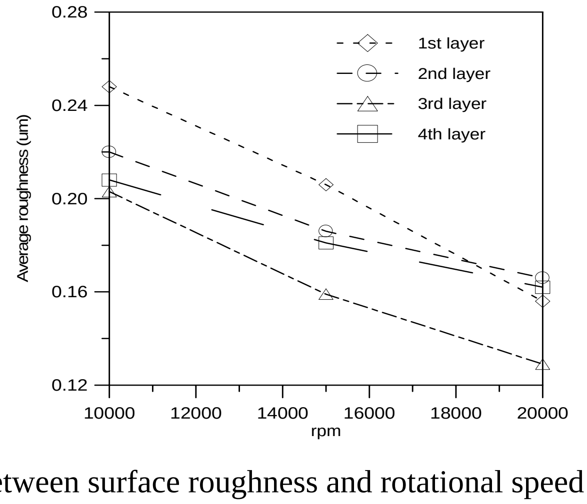

Figure 2 Relationship between surface roughness and rotational speed during different surface layers removing for TiN coating tool

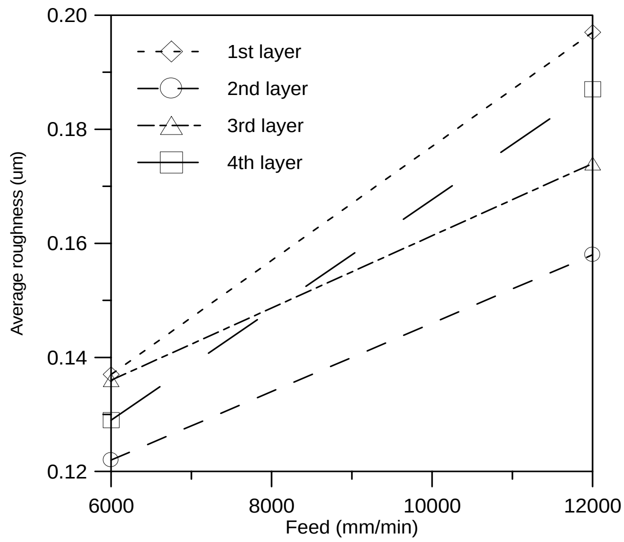

Figure 3 Relationship between surface roughness and feed rate during different surface layers removing for TiAlN coating tool

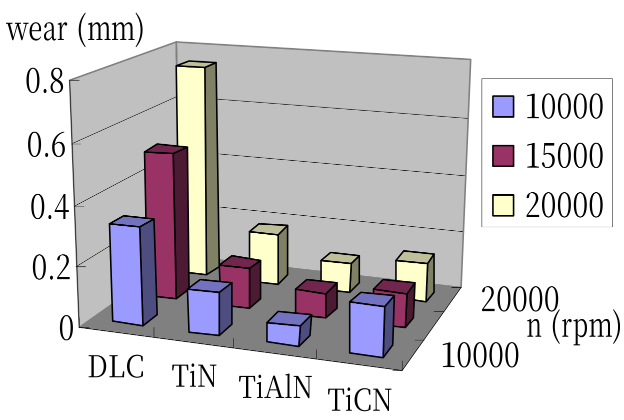

Figure 4 Relationships among flank wears, coating tools, and rotational speeds under the conditions of feed rate 6000 mm/min and depth of cut 0.5 mm

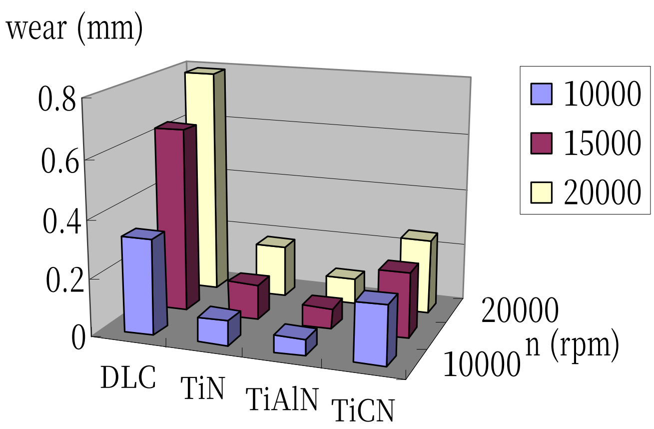

Figure 5 Relationships among flank wears, coating tools, and rotational speeds under the conditions of feed rate 12000 mm/min and depth of cut 1.5 mm

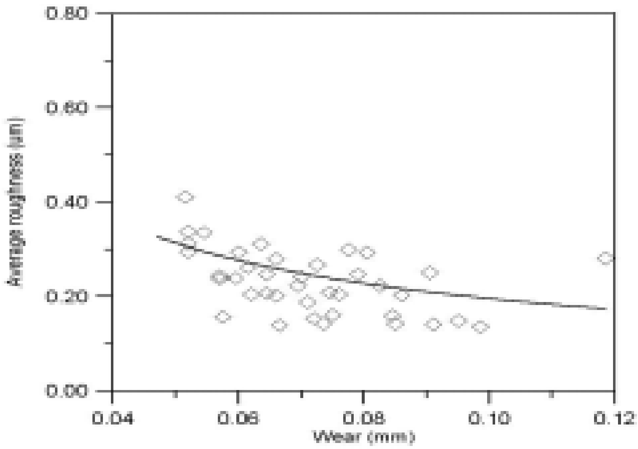

Figure 6 Relationship between surface roughness and flank wear for TiAlN coating tool

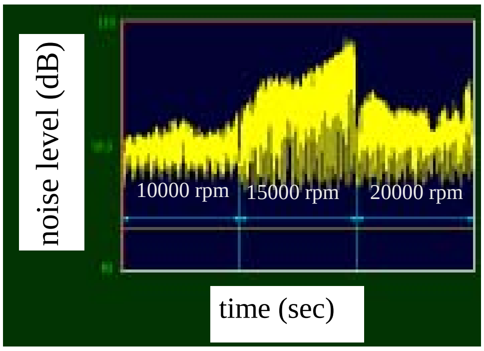

Figure 7 Noise level versus time elapse during different rotational speed ranges for DLC coating tool for machining of SKD61 mold steel

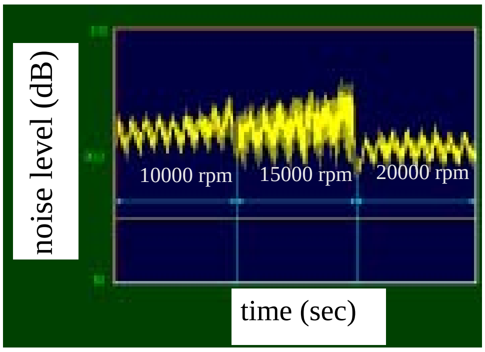

Figure 8 Noise level versus time elapse during different rotational speed ranges for TiN coating tool for machining of NAK80 mold steel

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